FORGING ALLOY FOR MANUFACTURING A GOLF CLUB HEAD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a forging alloy for manufacturing a golf club head.

2. Description of Related Art

Flow stress is a factor of malleability of metal, and the malleability stainless steel is generally poor than that of low-carbon steel and that of low-alloy steel. This is because the stainless steel is a high-alloy and thus has a flow stress higher than that of the low-carbon steel. Further, in order to avoid generation of other phases, coarse crystallites, and over flow stress and to improve the breaking strength and the like, the temperature for forging is strictly limited.

A typical forging alloy for manufacturing a golf club head is a low-carbon steel or low-alloy steel having lower hardness and higher malleability. A golf club head can be easily obtained by means of warm forging the low-carbon steel or low-alloy steel at the recrystallization temperature. The warm forging temperature (750-970 ℃) for the conventional forging alloy is relatively low and thus reduces the risk of generation of heat fatigue (heat-checking), oxidization, and deformation of the forging molds. The

conventional forging alloy is widely used in the golf club industry due to low forging temperature as well as a longer life for the forging molds. However, the rust-resistance of a golf club head manufactured by the conventional forging alloy is insufficient. Although this can be overcome by means of applying an anti-rust layer on the surface of the golf club head, the anti-rust layer per se has a low abrasion-resistance and is apt to peel off.

In an attempt to improve the rust-resistance of the golf club head at a higher cost, hot forging is adopted to overcome the high hardness and low malleability of stainless steel; namely, the hot forging of stainless steel must be preceded at a higher temperature and a higher pressure. However, surface oxidization and scaling occur easily during hot forging, and the precision of dimension of the resultant golf club head decreases. Further, heat-fatigue, oxidization, and deformation of the forging mold occur easily. On the other hand, as shown in Table 1 (according to Principal Metals, Inc. whose web site is at http://www.principalmetals.com) below, in order to avoid over flow stress, the forging temperature of stainless steel is strictly controlled between 954℃ and 1177℃, which requires additional equipment and results in difficulty of control.

Table 1

stainless steel type	Forging temperature
201	2100-2250°F (1149-1232℃)
304	2100-2300°F (1149-1260℃)
316	2100-2300°F (1149-1260℃)
405	immediately heating to 1900-2050°F (1038-1121℃) after forging at 1500-1600°F (817-871℃)
410	2000-2200°F (1093-1204℃), wherein the final processing temperature is not lower than 899℃
431	2100-2200°F (1149-1204℃), wherein the final processing temperature is not lower than 900℃
446	1600-2100°F (871-1149℃)
Alloy 253	1650-2000°F (900-1100℃)
Alloy 350	1800-2150°F (982-1117℃)
Alloy 355	1800-2150°F (982-1177℃)
Alloy 450	2100-2150°F (1150-1177℃)
Alloy 455	2100-2150°F (1150-1177℃)
17-4	keeping at 2150°F (1177℃) for an hour before forging, and

	the final processing temperature is not lower than 1850°F (1010℃)

OBJECTS OF THE INVENTION

An object of the present invention is to provide a forging alloy that is a martensite stainless steel forging alloy obtained through appropriate control of a mixing ratio among carbon, silicon, manganese, and chromium. The stainless steel forging alloy is highly malleable and thus allows warm forging for manufacturing a golf club head at a relatively low temperature. The lives of the forging molds are prolonged.

Another object of the present invention is to provide a martensite stainless steel forging alloy obtained through appropriate control of a mixing ratio among carbon, silicon, manganese, and chromium. The stainless steel forging alloy is highly rust-resistant and highly wear-resistant, and so is the golf club head manufactured by the stainless steel forging alloy.

SUMMARY OF THE INVENTION

A forging alloy for manufacturing a golf club head in accordance with the present invention is a martensite stainless steel alloy including carbon 0.08-0.16 wt%, silicon < 0.8 wt%, manganese < 1.0 wt%, chromium 11.5-17.0 wt%, with the remaining portion being iron. When the forging

temperature of the stainless steel alloy is below a transition temperature of a delta ferrite phase thereof, the stainless steel alloy can be subjected to warm forging in a smooth manner at a temperature of 720-960℃ and an operational force of 580-860 ton. Thus, a highly rust-resisting and highly wear-resistant golf club head can be manufactured.

Other objects, advantages and novel features of this invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram illustrating a process for manufacturing a golf club head in accordance with the present invention; and

Fig. 2 is a microphotograph of a sectioned golf club head manufactured by the forging alloy in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the present invention is now to be described hereinafter in detail.

A forging alloy for manufacturing a golf club head in accordance with the present invention is obtained from pure iron, silicoferrite, manganese iron, and chromium. The forging alloy in accordance with the present invention includes carbon 0.08-0.16 wt%, silicon < 0.8 wt%, manganese < 1.0 wt%,

chromium 11.5-17.0 wt%, with the remaining portion being iron. A stainless steel forging alloy is thus obtained in accordance with the present invention.

The stainless steel forging alloy in accordance with the present invention is a martensite stainless steel alloy that has a lower content of carbon, silicon, and chromium than that of the conventional stainless steel forging alloy to thereby reduce the hardness and wear-resistance and to thereby improve the malleability. On the other hand, the stainless steel forging alloy in accordance with the present invention has improved malleability when compared to the conventional low-carbon steel and the conventional low-alloy steel while maintaining the relatively higher hardness and the relatively higher wear-resistance of stainless steel than the conventional low-carbon steel and the conventional low-alloy steel.

When proceeding with forging of the stainless steel forging alloy, since the stainless steel forging alloy has improved malleability, sufficient plasticity of the stainless steel for continuous forging procedures can be obtained by means of heating to a temperature above 720℃, which is a relatively low forging temperature in the golf industry. Further, in order to avoid a decrease in the malleability and an increase in the forging pressure resulting from a sudden increase in the flow stress value required in the plastic deformation of the stainless steel, which, in turn, results from precipitation of

delta ferrite from the stainless steel as a result of excessively high temperature, in accordance with the present invention, the forging temperature of the stainless steel is controlled to be below the transition temperature of the delta ferrite phase thereof. Since the transition temperature of the delta ferrite phase depends on the contents of chromium and carbon, in accordance with the present invention, the contents of chromium and carbon are so selected that the forging temperature is maintained above 720℃ and not higher than 960 ℃. Forging of stainless steel forging alloy in this relatively low temperature range is called “warm forging”.

The pure iron and chromium used in the forging process in accordance with the present invention means pure iron (including a little amount of impurities) and pure chromium (including a little amount of impurities). The silicoferrite and manganese iron means a ferroalloy of silicon and a ferroalloy of manganese, respectively. The amounts of silicoferrite and manganese iron used in the forging process can be so adjusted according to their contents that the forging alloy obtained can be used to manufacture a golf club head having required properties. The stainless steel may contain other trace elements such as sulfur and phosphor as a result of different processes and materials.

Fig. 1 is a schematic diagram illustrating a process for manufacturing

a golf club head in accordance with the present invention. A stainless steel alloy obtained from the above-mentioned metallurgic process in accordance with the present invention is sliced into a plurality of forging ingots 10 having an appropriate size. The forging ingot 10 is subjected to several forging procedures while passing through several forging molds 11a-11d according to the need of product or process. The cavities 12a-12d respectively of the forging molds 11a-11d vary in shape in sequence to thereby gradually forge the forging ingot 10 to a shape corresponding to the respective cavity 12a-12d, thereby forming blanks 10a-10d of a golf club head. In a case that four forging molds 11a-11d are used, the temperature of the respective forging mold 11a-11d can be selected according to the amount of plastic deformation. For example, the temperatures of the forging molds 11a-11d can respectively be 940-960℃, 870-930℃, 820-880℃, and 720-780℃ while maintaining the forging force at 580-860 ton. Finally, the golf club head blank 10d is subjected to several surface finishing procedures to obtain a golf club head (not shown) having high rust-resistance and high wear-resistance.

Fig. 2 is a microphotograph of a sectioned golf club head manufactured by the forging alloy in accordance with the present invention. A golf club head obtained by the above procedures is sectioned and then micro photographed. As can be seen in Fig. 2, the stainless steel forging alloy still

has the metalgraph of martensite after several heating and forging procedures. Further, since the hardness of the stainless steel forging alloy can be adjusted in a relatively wide range (HRb 85- HRc 50), the hardness of the golf club heads can be adjusted according to the types of the golf club heads. More specifically, the hardness for a wedge shaped golf club head having a relatively larger angle is reduced for improving the control of the golf ball. The hardness of an ordinary iron club head can be higher to increase the flying distance of the golf ball. Further, the hardness of the golf club heads can be adjusted according to the need of the golfers.

According to the above description, the forging alloy in accordance with the present invention has high malleability, high rust-resistance, and high wear-resistance, which cannot be obtained from the low-carbon steel, low-alloy steel, or the conventional stainless steel. The forging alloy in accordance with the present invention is obtained through appropriate control of the ratio among carbon, silicon, manganese, and chromium to improve the physical and chemical properties. Thus, a highly rust-resisting and highly wear-resistant golf club head can be manufactured, and the lives of the forging molds are prolonged.

While the principles of this invention have been disclosed in connection with its specific embodiment, it should be understood by those

skilled in the art that these descriptions are not intended to limit the scope of the invention, and that any modification and variation without departing the spirit of the invention is intended to be covered by the scope of this invention defined only by the appended claims.